CENPP-PL-CH 20 December 1988

RESULTS OF 1988 LOWER WILLAMETTE RIVER SEDIMENT QUALITY TESTING-- USACE PORTLAND DISTRICT O&M DREDGING

Introduction

The navigation channel on the Willamette River between RM 2 and the Broadway Bridge (RM 11.7) contains shoals of fine grained sediment. In order to return the navigation channel to project depth of -42 feet (authorized depth -40 feet, plus 2 feet for overdredging), approximately 400,000 cubic yards (cy) of material will have to be dredged. Dredging is proposed for summer 1989. All dredged materials with acceptable water and sediment quality will be disposed at a dispersive in-water site in the Columbia River. The site is located 0.5 mile downstream of the Willamette River mouth, in a scour area, on the south side of the river.

Chemical and biological testing for contaminants in shoal sediments was completed to determine whether the disposal discharges into the Columbia River will meet Clean Water Act Section 401 water quality standards, and to avoid unacceptable adverse impacts on either water column or benthic aquatic life.

Sampling Procedures

Sediment samples were collected on 22 and 23 March and 20, 22, and 25 April from shoals between RM 4.3 to 11.7 (Figure 1). A gravity corer and Ponar grab sampler were to collect the March samples at RM 4.3, 5.1, 7.1, 7.3 and 11.7. A small vibracorer was used to collect the April samples at RM 8.1(2), 8.3, 8.7, 9.0(2), 9.2, 9.6, 10.3, 10.7, 11.3. Choice of the sampler type was determined by the type of sediment and the thickness of the shoal. The grab sampler was used for gravels, the gravity corer for thin shoals, and the vibracorer for thick shoals. Sites at RM 2.3, 4.1 and 10.0 were dropped from the initial sampling plan.

In September, stations at RM 10 and 10.3 were resampled, and samples collected at stations at RM 2.1 and in lower Oregon Slough. Most of the samples were taken near the edges of the navigation channel in the proximity of outfalls and ship moorings. Two samples were taken farther out into the channel in order to provide information on contamination level gradients.

Testing of sediment samples included physical analysis, bulk chemistry and elutriate testing. Receiving water was collected in May from the disposal area in the Columbia River for use in elutriate testing. When appropriate, samples of similar sediments at Willamette RM 8 and 9 and at Oregon Slough were composited.

Sediments

In general, the material sampled from RM 10.7 and downstream was silt with individual sandy or clayey layers. The upper portion of the cores was typically very soft silt, becoming more compact with depth. The lower portion of the cores varied between clayey, silty or sandy material. Many of the cores, especially the long ones, included a discrete layer of undecomposed plant material several feet down from the top. The plant material was usually associated with a local coarsening of the surrounding sediment. In all cases the sediments throughout the cores had a brownish, oxygenated appearance, and lacked the dark coloration and rotten odor associated with anoxic environments.

The sediment taken from RM 11.3 was very sandy in contrast to the other cores. The shoal at the Broadway Bridge (RM 11.7) turned out to be mostly coarse gravel, and included fragments of unrounded siltstone, perhaps indicating the proximity of bedrock.

Results from Chemical and Biological Testing

Results from chemical and biological testing were returned to CENNPP-PL-CH during June, July and November 1988 (Table 1 and Attachment 1). They are summarized as follows:

1. Bioassays were run on four sediment samples at RM 4.3, 5.1, 7.1 and 7.3. These samples had between them the highest recorded heavy metals concentrations for all priority pollutants tested except lead. They also contained the highest concentrations of most of the organic compounds found. One sample (7.1) showed significant mortality in the dissolved phase, while none showed mortality in solid phase tests. While sample 7.1 is from the Doane Lake area, an area being investigated under EPA Superfund authority, chemistry results showed no unusual elevations of either metals or organic contaminants. Mortality may have been caused, therefore, by elevated ammonia or depressed oxygen in test containers, since the dissolved phase

tests were static tests. Those sediments did not show solid phase toxicity in either 48-hour or 10-day tests.

2. Elutriate test results for metals showed that all were below freshwater chronic toxicity standards for water quality (EPA "Gold Book" water quality criteria, 1986) for the four samples tested, including sample 7.1. Maximum releases ranged from 0.5% (Ag) to 46.1% (Pb) of the water quality standards. Ammonia releases were high, ranging from 14.7 to 20.6 ug/L. These releases exceeded the chronic toxicity standard of 2.9 ug/L but were below the acute toxicity standard of 33 ug/L. The highest ammonia release occurred for station 7.1, the Doane Lake site that showed dissolved phase bioassay mortality.

3. Sediment contaminant levels on the lower Willamette River and Oregon Slough areas generally fall below screening levels for non-toxic fresh water and marine sediments in other areas of the country (Great Lakes, New England and Puget Sound). However, sediments at RM 4.3, 7.3, 7.45-8.0, 8.1/9.0, 9.8, 10.3, 10.7/11.3 and at the Broadway Bridge (RM 11.7) showed elevated contaminant levels for cadmium (10.3, OS-1/2), copper (7.3, 7.45-8.0, 8.1/9.0, 10.3), mercury (4.3, 7.3, 9.8), lead (10.3, 11.7), zinc (4.3), DDD (7.3), and total PAHs (2.1, 4.3, 5.1, 7.3, 7.45-8.0, 11.7).

4. The lead and total PAHs levels at the Broadway Bridge (RM 11.7) were highly elevated above present levels of concern. Substantial elevations also occurred with PCBs at the RM 10.3 shoal, DDTs at RM 7.3, and cadmium at Oregon Slough. Some localized temporary contaminant elevation in bedload and suspended sediments within and downstream of the disposal site is expected to occur, although the observed levels are not of concern from a toxicity standpoint. These levels indicate that some contaminants in several specific shoals are substantially elevated above what is considered to be background levels for Oregon sediments.

Recommendations

1. The chemical and biological test data generated in this program greatly exceed previous sediment quality evaluations in the lower Willamette River. They are representative of the Federal project sediments to be dredged. Biological tests were conducted on the most contaminated sediments. There is no need for further chemical or biological testing unless additional

shoal areas will be dredged for which there would be a reason to believe that different or higher contaminant levels exist.

2. Most sediments to be dredged are acceptable, from a toxicity standpoint, for unconfined in-water disposal in the Columbia River. This includes sediments from the main shoal on the south side (left bank) of the river between river miles 8.0 and 10.1, and from a mid-channel shoal at river mile 2.1. We would not reasonably expect acute or chronic toxicity/bioaccumulation effects from inwater disposal of these sediments.

3. Sediments from the shoals at river mile 7.0 - 7.5, 10.3, and 11.7 (Broadway Bridge), should be placed in alternate confined in-water or upland sites due to elevated levels of DDD (7.0 - 7.5), PCB (10.3), and lead (11.7), and significant dissolved phase bioassay mortality (7.0 - 7.5). RM 10.3 has been included because, although sediments were not subjected to bioassay, PCBs are persistent and tend to bioaccumulate in the environment. While the most DDD-contaminated sediments did not cause mortality, bioaccumulation potential in lower Columbia River biota are sufficient that this material should not be dispersed through the ecosystem.

4. Sediments from the downstream portion of Oregon Slough have high levels of cadmium, although other contaminants were at low to moderate levels. This material should undergo elutriate testing to see if water quality standards will be exceeded by inwater disposal.

Report Preparation

This sediment quality evaluation was completed by Mr. Bill Fletcher, Mr. Rudd Turner, and Ms. Sally Babcock of the Coastal and Flood Plain Management Branch, Planning Division, USACE Portland District. Analytical chemistry was performed under the direction of Dr. Eric Crecilius, Battelle Northwest Marine Sciences Laboratory, Sequim, Washington. Heavy metal analyses were run by Battelle at the Sequim lab while organic anlayses were run by Analytical Resources Inc., Seattle, WAshington, under contract to Battelle.

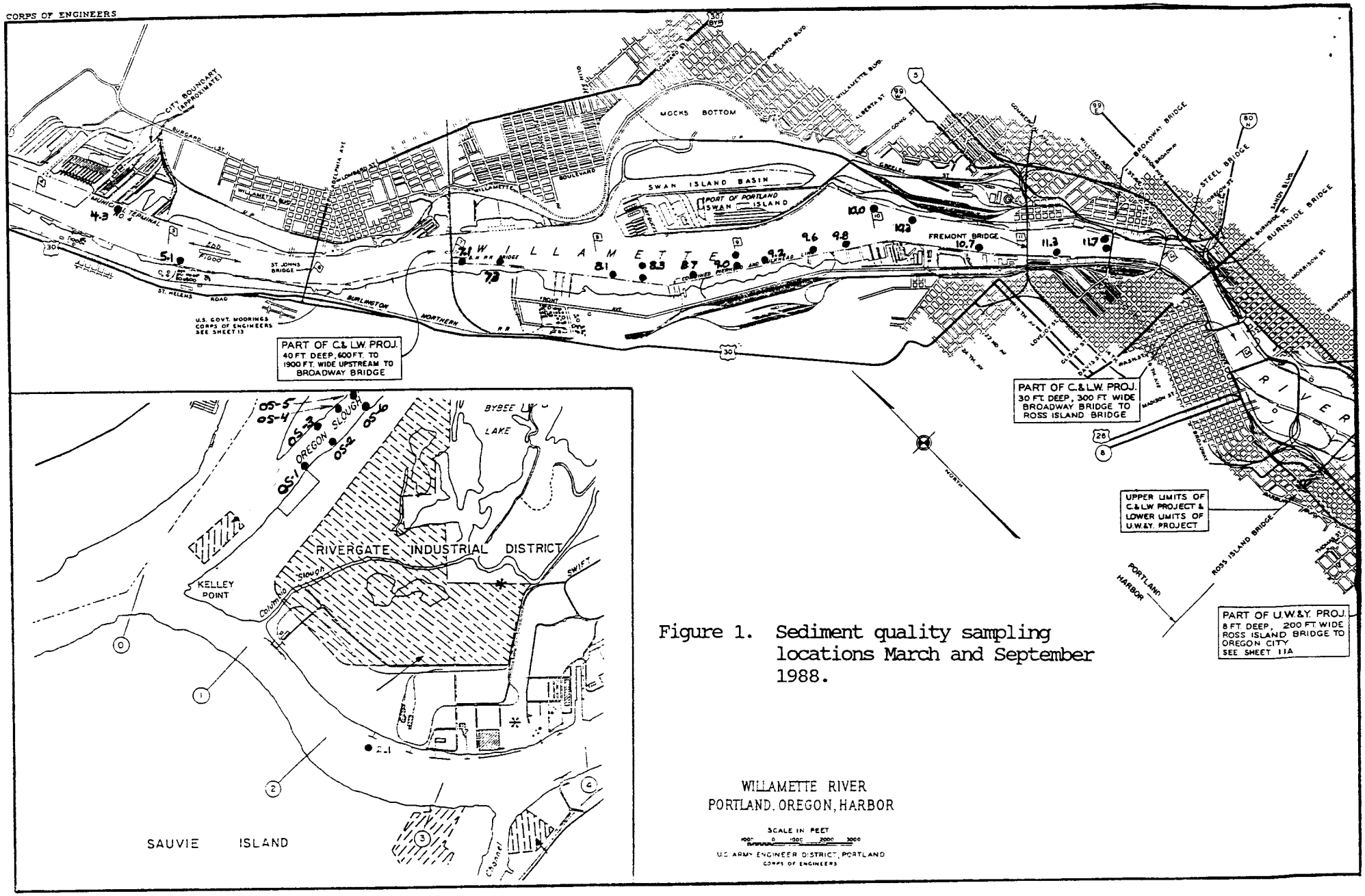

Figure 1. Sediment quality sampling locations March and September 1988.

WILLAMETTE RIVER
PORTLAND, OREGON, HARBOR

SCALE IN FEET
100' 0 1000 2000 3000

U.S. ARMY ENGINEER DISTRICT, PORTLAND
CORPS OF ENGINEERS

Table 1. Chemical analyses for sediment and water quality on Lower Willamette River and Oregon Slough sampling locations.

SEDIMENT QUALITY ANALYSES FOR METALS AND ORGANICS FOR LOWER WILLAMETTE RIVER

																					OREGON SLOUGH	
SEDIMENT SAMPLE NO.		LWR-2.1a/b	4.3	5.1	5.1d	7.1	7.3	MC-1/2/3	MC-4/5/6	8.1/9.0	8.1/9.0c	8.3/8.7	9.2/9.6	9.8	LWR-10.0	LWR-10.0d	10.3	10.3a	10.3b	10.7/11.3	11.7c	OS-1/2	OS-4/6
RIVER MILE		2.1	4.3	5.1	5.1	7.1	7.3	7.45-8.0	7.45-8.0	8.1 & 9	8.1 & 9	8.3 & 8.7	9.2 & 9.6	9.8	10.0	10.0	10.3	10.3	10.3	10.7 & 11.3	11.7c		
DATE SAMPLED		9/88	3/88	3/88	3/88	3/88	3/88	12/86	12/86	3/88	3/88	3/88	3/88	3/88	9/88	9/88	3/88	9/88	9/86	3/88	3/88	9/88	9/88
PHYSICAL CRITERIA																							
	% FINES	80.6	67.5	72.1	72.1	84.6	80.3	89.9	84.47	88.7	79.95	76.05	65.95	74.5	53.7	51.7	56.75	59.4	78.2	58.85	6.3	44.4	13.75
	% VOL SOL	7.3	7.87	7.6	7.6	7.2	8.2	8.1	7.83	8.88	7.19	7.74	7.8	7.89	5.2	5.2	6.25	6	6	6.4	2.4	2.9	1.7
	OIL/GREASE (ppm)							1852	1976					17.3						15.2			
	AMMONIA/NH4 (ppm)		20.6							14.7							5.9			9.63	2.39		
	TOC (mg/g)		12.4	17.4	17.4	12.7	15.2	2.4	2.3	17.45	14.8	13.05	14.45	15.5									
CHEMICAL CRITERIA																							
METALS	ARSENIC	4.1	5.1	4	4	3.5	5.1	7.4	6.6	4.4	2.8	3.3	4.4	2.6	4.37	4.51	4.8	3.49	3.69	3.4	4.3	4.34	3.21
(ppm)	CADMIUM *	0.72	0.65	0.32	0.32	0.36	0.39	0.269	0.272	0.32	0.31	0.29	0.22	0.26	0.19	0.15	0.44	0.72	0.21	0.35	1.65	1.2	0.435
	CHROMIUM	36	22	24	24	24	26	110	82	26	24	22	24	24	36	36	20	24	32	22	30	22	16
	COPPER	47.62	47	46	46	49	53	51	52	50	46	44	42	43	43.01	39.94	46	76.11	39.94	45	42	25.35	16.13
	IRON		3.18	3.3	3.3	3.32	3.74			3.44	3.38	3.29	3.35	3.24			3.01			3.23			
	MERCURY	0.11	0.21	0.07	0.07	0.08	0.14	0.058	0.041	0.08	0.1	0.07	0.06	0.16	0.067	0.058	0.13	0.054	0.071	0.1	0.08	0.047	0.023
	MANGANESE		426	755	755	676	475			904	644	634	734	776			570			405			
	NICKEL	19.28	37	34	34	39	42			39	38	39	36	36	19.28	19.28	34	13.77	16.53	37	27	12.4	11.05
	LEAD	23.57	33.7	20.1	20.1	20.1	33.3	25	25	23.8	17.2	19.2	13.8	16.7	19.52	17.07	35.8	83.36	31.74	53.6	118	13.6	6.01
	ZINC	166.79	252	134	134	137	159	134	140	134	140	146	36	125	117.54	108.14	144	109.7	176.1		107	132.7	75.13
* FURNACE ANALYSIS																							
PESTICIDES	ALDRIN																						
(ppb)	CHLORDANE																						
	DIELDRIN														0.7	6.6			2			3.6	1.6
	DDD	5.4	18	11		18	270			4					0.6	3.7			1.1			2.6	1.4
	DDE	2.8						4	2														
	DDT																						
	ENDOSULFIN																						
	ENDRIN																						
	HEPTACHLOR																						
	LINDANE																						
	METHOXYCHLOR																						
	TOXAPHENE																						
PCBs (ppb)	Aroclor 1248						275										240						
	Aroclor 1254	14													5.3	24			7.4	60		3.1	
	Aroclor 1260	5.6	75					69	21				60	50	3.1	45	120	280		30			
PAHs (ppb)	ACENAPHTHENE	170	180																		1		
	ACENAPHTHYLENE		70																		2.2		
	ANTHRACENE																				1800		
	FLUORENE	90	90																		400		
	NAPHTHALENE	74													78				110		13000	28	
	PHENANTHRENE	450	390	420	210			60	68														
	B. ANTHRACENE							430	581				990	930						440			53
	B. FLUORANTHENE		3300	3600	1800	610	1900	354	623	1400					85	100							
	B. PYRENE	180						77	121														
	CHRYSENE		80	80			790																
	D ANTHRACENE							179	423										260		11000		
	FLUORANTHENE	490	540	640	430										120			120	180		11000	87	38
	PYRENE	560	640	760	550			51	57													52	
TOTAL PAHs		2014	6010	6220	2990	610	2690	1509	2152	1400	0	0	990	930	283	100	0	120	550	440	40400	167	91
	PENTACHLOROPHENOL					0.6				0.7										1			
	PHENOL									0.7													
	2,4-DINITROPHENOL					12				17													
	2 METHYL - 4,6 DINITOPHENOL					2.7				3.6										1.6			

WATER QUALITY ANALYSES FOR METALS FOR LOWER WILLAMETTE RIVER

SEDIMENT SAMPLE NO.		7.1	8.1/9.0	9.8	10.7/11.3
RIVER MILE		7.1	8.1 & 9	9.8	10.7 & 11.3
DATE SAMPLED		3/88	3/88	3/88	3/88
METAL CONCENTRATIONS (ppb)					
WATER BLANK	Ag	0.003	0.003	0.003	0.003
	ARSENIC	0.82	0.86	0.86	0.86
	CADMIUM *	0.035	0.605	0.605	0.605
	CHROMIUM	0.143	0.169	0.169	0.169
	COPPER	1.12	1.97	1.97	1.97
	IRON	7.67	5.93	5.93	5.93
	MERCURY	0.0007	0.0014	0.0014	0.0014
	MANGANESE	1.76	1.49	1.49	1.49
	NICKEL	0.852	0.89	0.89	0.89
	LEAD	0.059	0.07	0.07	0.07
	ZINC	4	20.99	20.99	20.99
ELUTRIATE	Ag	0.001	0.003	<0.001	0.022
	ARSENIC	1.24	3.12	1.57	1.07
	CADMIUM *	0.006	0.007	0.005	0.016
	CHROMIUM	0.052	0.169	0.039	0.43
	COPPER	0.083	1.93	0.393	3.15
	IRON	431	220	6.59	520
	MERCURY	0.0022	0.0043	0.0004	0.0017
	MANGANESE	6640	330	1100	70
	NICKEL	9.19	0.555	2.72	3.04
	LEAD	0.086	0 a12	0.027	1.475
	ZINC	9.11	1.94	3.65	7.17

BIOASSAY SUMMARY

LOWER WILLAMETTE RIVER SEDIMENT SAMPLES

A series of toxicity tests were conducted with sediments collected from the lower Willamette River March 23, 1988. The US Army Corps of Engineers collected sediment core samples in the river near Pennwalt Chemical (rm 7.3), Doane Lake (rm 7.1), Mobil Oil (rm 5.1), and the Port of Portland Terminal 4 (rm 4.4). Control sediments were collected by the DEQ from a small pond at the Audubon sanctuary in northwest Portland.

The toxicity of the sediments was determined with elutriate and solid-phase bioassays. The elutriate-phase test exposes test animals to dissolved substances released from the sediments when they are vigorously mixed with water. Control water is mixed with the sediment samples and the elutriate collected after settling and centrifugation. In the solid-phase bioassay, test organisms are placed in test chambers which contain sediments and control water. Unlike the elutriate-phase test, no intentional mixing of the sediments and water occurs prior to testing.

Elutriate-phase results. Daphnia magna were exposed for 48 hours to elutriate from each sediment sample. Toxicity tests were conducted in triplicate with a total of 30 animals used for each sediment sample. A significant reduction in survival was seen in animals exposed to the Doane Lake elutriate. Daphnia survival in the other treatments was no different than control survival.

Solid-phase results. D. magna and midge (Chironomus riparies) solid-phase bioassays showed no significant differences in survival among control and test sediments. The 48 hour Daphnia tests were conducted in triplicate with a total of 15 animals per sample. The midge test was 10 days long and

duplicates of 15 larvae each (30 animals in total) were used for each treatment.

The replicate survival mean and standard deviation for each treatment is shown below. Data were evaluated with an unpaired Student's t-test ($p=0.05$), and significant differences from control values are identified with *.

		elutriate	solid phase	solid phase
		Daphnia	Daphnia	Chironomus
	Control:	9.7 ± 0.6	4.7 ± 0.6	11.5 ± 4.9
RM 7.3	Penmwalt:	9.7 ± 0.6	3.7 ± 1.5	12.5 ± 2.1
RM 7.1	Doane Lake:	1.0 ± 1.0 *	4.7 ± 0.6	12.5 ± 2.0
RM 5.1	Mobil Oil:	10.0 ± 0.0	3.3 ± 2.1	12.5 ± 0.7
RM 4.4	Terminal 4:	9.7 ± 0.6	3.0 ± 1.0	11.0 ± 5.7
	Original no per replicate:	10	5	15

The release of bound substances from the sediment in the preparation of the elutriate probably accounts for the different results seen in the Doane Lake tests. Elutriate from Doane Lake sediments was toxic to D. magna, while the less disturbed sediments in the solid phase test were not. No toxicity was seen in the midge larvae, which burrow through the sediments coming in contact with materials sorbed to the sediment and dissolved in the interstitial waters and overlying water column. No toxicity was seen in any of the other sediment samples tested.

The Doane Lake sediments and elutriate were orange, or rust colored in appearance, and an oily slick formed at the water's surface. The Penmwalt, Mobil Oil, and Terminal 4 samples were also oily in appearance. The Army

Corps will be providing more comprehensive analytical data for each of the tested sediments.